Flying-foxes and tourists: a conservation dilemma in the Northern Territory

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ABSTRACT

A small colony (1 000–5 000) of Little Red Flying-foxes *Pteropus scapulatus* is usually resident at Mataranka Hot Springs in the semi-arid zone of the Northern Territory of Australia between October and February. In 1994–95 this changed markedly. More than 200 000 individuals were present and most did not depart until July. The colony generated a powerful smell and caused significant damage to the vegetation surrounding the Spring, resulting in conflict with tourist use of the area. Many methods were employed in attempts to shift animals, but none was successful. The situation is an extreme example of the problems caused by Australian *Pteropus* and highlights a general lack of information and effective management techniques for the genus and its habitats. Information on the sex ratio and breeding condition of females at the colony is presented.

Key words: Flying-fox, *Pteropus*, Northern Territory, bat, conflict with wildlife.

INTRODUCTION

The Little Red Flying-fox *Pteropus scapulatus* is the least known of the Australian *Pteropus*, despite some general information being available (e.g., Ratcliffe 1931; Nelson 1965; Prociv 1983; Hall 1987; Thomson 1991; Sinclair *et al.* 1996). It is the smallest (adult weight 300–600 g), most nomadic and most widespread of the Australian Flying-foxes (Hall 1987; Tidemann 1993). In Australia it has a range in excess of 3.5 million km^2 (Sinclair *et al.* 1996) but has also been collected on Ashmore Reef, several times in Papua New Guinea and once in New Zealand (Daniel 1975; Waithman 1979; Pike 1990; Sinclair *et al.* 1996). Within the Northern Territory it is widely distributed. Like most other *Pteropus* it is nocturnal, forming colonies (sometimes called haunts, roosts or camps) during the day in trees, palms or bamboo, usually near or over water (C. Tidemann, R. Loughland and M. Vardon, unpubl.). Colonies range in size from a few dozen to as many as 1 000 000 individuals (Nelson 1965; Hall 1987). *Pteropus scapulatus* sometimes roosts with *P. alecto* and *P. poliocephalus* (Ratcliffe 1931; Nelson 1965; Hall 1987; Tidemann 1993) and despite seemingly obvious differences in appearance can be difficult to differentiate from *P. alecto* in northern Australia (Johnson 1964; M. Vardon and C. Tidemann, unpubl. obs.). In the north the colour of some *P. scapulatus* is much darker, almost brown, and the mean size of the species is significantly larger (E. Sinclair, pers. comm.).

Each evening, after sundown *Pteropus* colonies exit their daytime roosts to forage for food. The foraging area of *P. scapulatus* is unknown, although for *P. poliocephalus* it is within 17–25 km of the roost (Spencer *et al.* 1991) and for *P. alecto* is up to 25 km (C. Palmer, pers. comm.). The flowers and fruits of hardwood trees (especially flowers of *Eucalyptus* and *Melaleuca* species) provide the main source of food for *P. scapulatus* (Ratcliffe 1931; Nelson 1965; Tidemann 1993; Sinclair *et al.* 1996; Richards 1995), although lerps (Law and Lean 1992) are also eaten. *Pteropus scapulatus*, like other Australian *Pteropus*, can move great distances over time (Ratcliffe 1931; Nelson 1965; Eby 1991; Sinclair *et al.* 1996; Richards 1995; Webb and Tidemann 1996). Australian *Pteropus* move in response to food availability (Ratcliffe 1931; Nelson 1965; McWilliam 1986; Richards 1990; Eby 1991; Parry-Jones and Augee 1992; Tidemann 1993; Richards 1995) and probably reproductive cycles.

Pteropus scapulatus mates in December-January and young are born in April-May (Martin *et al.* 1987; Thomson 1991; O'Brien 1993; Sinclair *et al.* 1996; Martin *et al.*, 1995). In northern Australia the time of birth for *P. scapulatus* overlaps with that of *P. alecto* (Andersen 1912; Thomson 1991; Tidemann *et al.*, in press). One young is born per year to females two or more years old (Ratcliffe 1931; Sinclair *et al.* 1996). After birth young are carried by their mothers during foraging expeditions until they are too large to be lifted. When this occurs (at about 4–6 weeks) young are left in the daytime roost while the mother forages. Young commence flying at around 12 weeks.

For several months each year a colony of *P. scapulatus* occupies a site on the Waterhouse River near or around the Mataranka Hot Springs (14°55'S, 133°08'E), approximately 400 km south-east of Darwin, Northern Territory (Fig. 1). Around 1 000–5 000 individuals have occupied the site between October and February

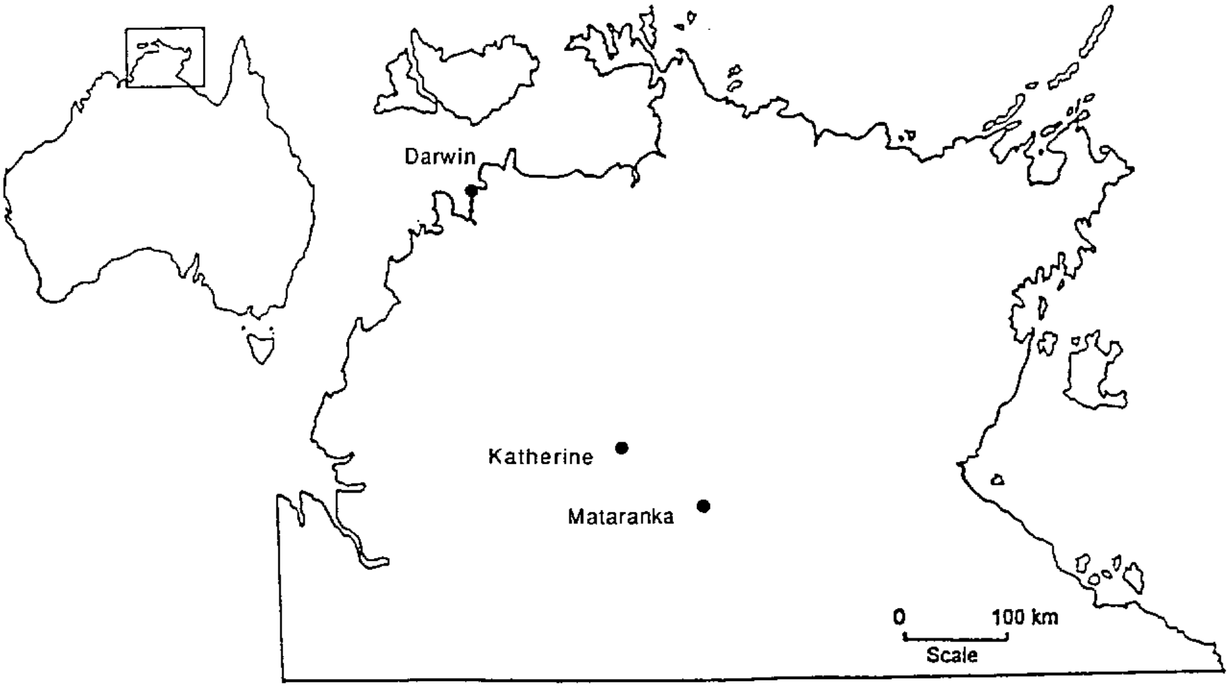


Figure 1. The location of Mataranka in the Northern Territory of Australia where more than 200 000 Little Red Flying-foxes *Pteropus scapulatus* made their home for a short time in 1995.

each year for at least 20 years (D. Sherwell, unpubl.). However, from October 1994, the population gradually increased to many times its usual size until departing in March 1995. Animals then returned in April in even greater numbers and did not depart finally until 9 July 1995. The maximum size of the colony was estimated to be 250 000 on 17 April 1995 (C. Palmer, pers. comm.). In addition to the unusually large numbers of animals present, this is the longest known stay of the colony and the first time that births have been recorded at Mataranka.

Pteropus scapulatus at Mataranka roosted chiefly in Livistona Palm *Livistona rigida* and Silver-leafed Paperbark *Melaleuca argentea*, although several River Red Gums *Eucalyptus camaldulensis* were also occupied. Elsewhere in the Northern Territory they roost in Mangroves *Avicennia marina*, Bamboo *Bambusa arnhemica* and monsoon forest patches (C. Tidemann, R. Loughland and M. Vardon, unpubl.). The vegetation surrounding the colony (radius 15 km) at Mataranka is a mixture of *Eucalyptus* woodland (79.7%) and *Melaleuca* forest (20.3%) (Wilson *et al.* 1990).

The size of the colony and length of its stay, while an impressive biological phenomenon, created a range of problems. Mataranka Hot Springs is a popular tourist destination and people bathe in the springs throughout the year, with peak use during the dry season (April-September). Defaecation by *P. scapulatus* roosting over the bathing area created an apparent public health problem and the smell generated was powerful and unpleasant to most visitors.

At Mataranka all of the trees and palms occupied by *P. scapulatus* were damaged to some degree, with the most severe occurring to *M. argentea*, most of which had all leaves and fine branches stripped. Branches at least 25 cm in diameter were broken from trees. In Queensland, branches 20–35 cm in diameter are reported to have been broken (Ratcliffe 1948; Hall and Richards 1991). A fire that occurred around the Springs added to the problems caused by defoliation, reducing the surrounding ground cover to ash and blackening the trunks of many trees and palms. Some mature *M. argentea* were killed as a result of *P. scapulatus* occupation and/or the fire.

The tourist industry was adversely affected by the deterioration of the aesthetic values of the Spring. Because of this and concerns for the vegetation in the area, actions designed to move the colony from the area were undertaken. This paper aims to advance our understanding of *P. scapulatus* and its managment needs by describing the influx of the species at Mataranka, the problems caused by it and the responses to them. This is important since the problems at Mataranka are not unique to the area or the species. However, the problems caused by *P. scapulatus* are the most severe since they form the largest colonies of Australian *Pteropus* (Hall and Richards 1991), and roost at higher densities (Tidemann, unpubl.).

Recent examples of problem colonies are: *P. poliocephalus* at the Botanic Gardens in Melbourne (Peak *et al.* 1996) and Sydney (B. G. Briggs, pers. comm.); *P. scapulatus* causing electrical blackouts at Adelaide River Township

(Northern Territory) in 1996 (M. Vardon, unpubl.) and seriously degrading vegetation at Wingham Brush (New South Wales) in 1995 (Bell 1995), and *P. alecto* and/or *P. scapulatus* at Jabiru (Kakadu National Park, Northern Territory) in 1996 (A. Spiers, pers. comm.). No attempts to move problem *Pteropus* colonies have been well documented, therefore preventing an evaluation of the effectiveness of the different methods employed. Successful displacement of a colony occurred in Sydney Botanic Gardens in 1992 and 1995, where a large bell was rung repeatedly in the morning (07:00–10:00) and afternoon (15:30–16:30). Historically, organized "shoots" and destruction of roosting vegetation were used (Hall and Richards 1987).

Estimating the colony's size

Estimating the size of large colonies of *Pteropus* is difficult. The chief method used recently has been exit counts, in which animals are counted as they leave the daytime roost at dusk (e.g., Parry-Jones 1987). Ground transect procedures (e.g., Ratcliffe 1931; Nelson 1965; Baranga and Kiregyera 1982) and other methods (see Mickleburgh *et al.* 1992) have also been used. None has been checked for accuracy or precision but Ratcliffe (1931) believed exit counts over-estimated numbers while ground procedures under-estimated numbers.

The colony's size at Mataranka was estimated four times in 1995: 17 April; 30 April; 14 May and 4 July (Table 1). The first was based on an exit count by Carol Palmer of the Parks and Wildlife Commission. The other three estimates (by MV and BS) used ground procedures where the area occupied by the population was roughly mapped (using available topographic and tourist maps) and *P. scapulatus* counted in a sample of the total colony area.

Table 1. Estimated size, sex structure and breeding condition (%) of females at the Mataranka *P. scapulatus* colony 17 April–4 July 1995

	17 April	30 April	14 May	4 July
Estimated Population	250 000	160 000	65 000	430
Sex ratio (%)		(N = 96)	(N = 48)	(N = 25)
— Males		28.6	29.1	4.0
— Females		71.4	70.9	96.0
Breeding condition of females (%)		(N = 68)	(N = 34)	(N = 24)
— pregnant		18.6	32.4	0.0
— with young		72.1	52.9	95.8
— neither		10.3	14.7	4.2

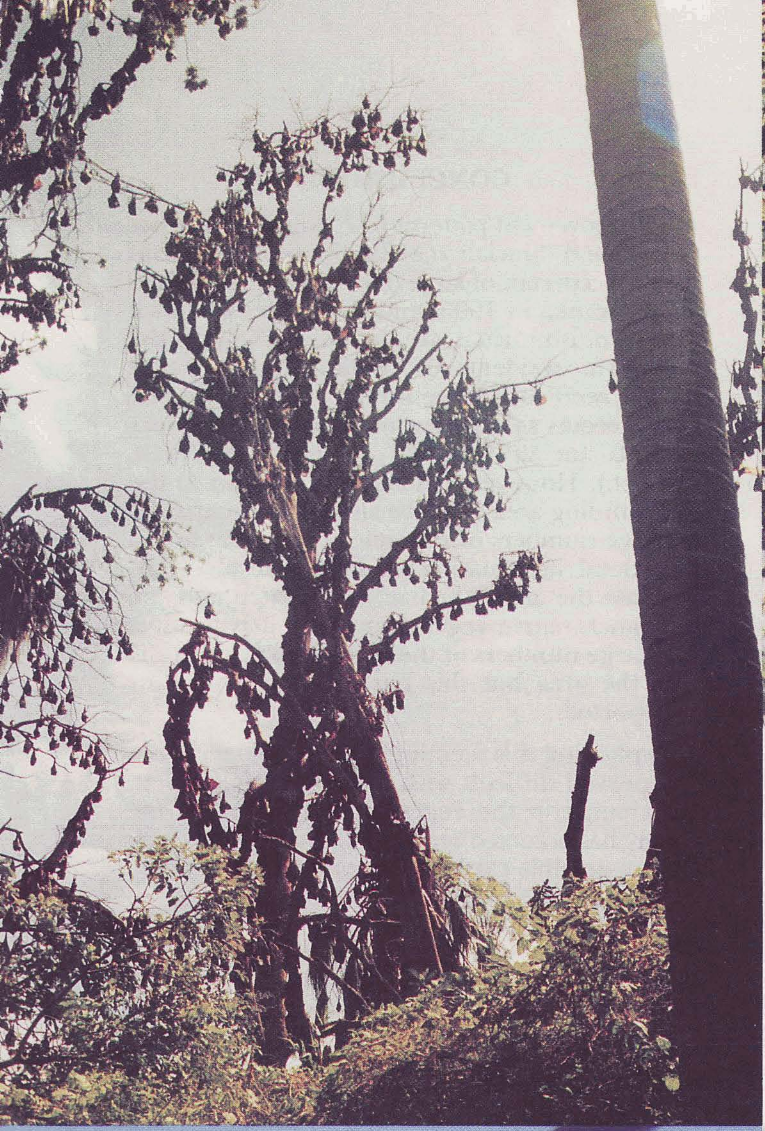
Population sex structure and female breeding condition

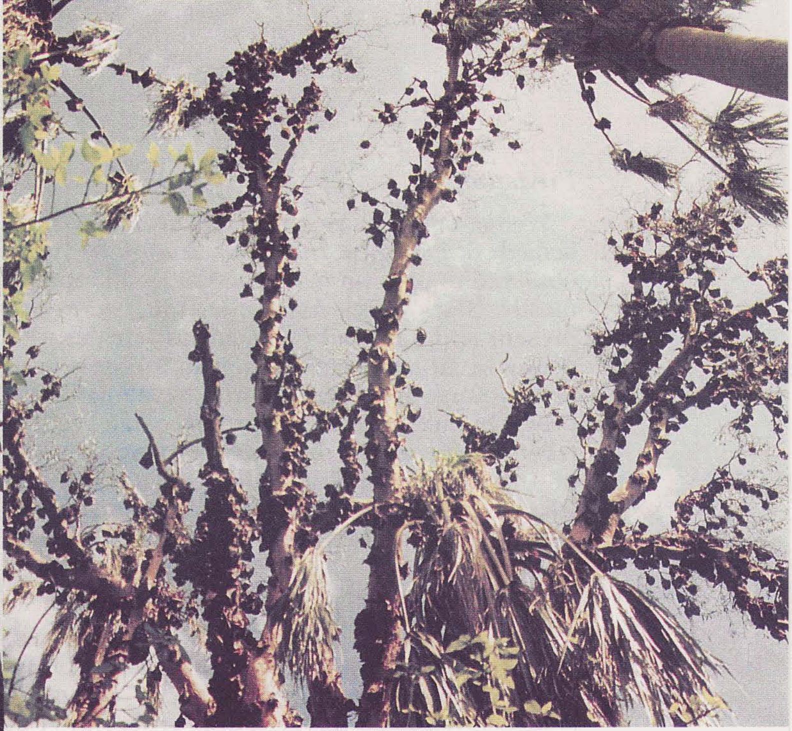
Sex structure of the population and the breeding condition of females was determined visually from a random sample of *P. scapulatus*. The sample was taken from points spread throughout the colony. With binoculars, male genitalia are clearly visible and hence most animals can be sexed easily. Those that had their wings wrapped around their bodies, or genitalia otherwise obscured, were ignored in sampling. However, it is possible that sub-adult males, because of small genitalia, could be confused with sub-adult or adult females without young. Breeding condition of females was categorized as: (1) with young, (2) heavily pregnant (3) neither pregnant nor with young. The last category would include all sub-adult females and some adult animals. Breeding condition categories of all females were readily discernible: the presence or absence of young and the enlarged abdomens of females in the final stages of pregnancy were almost unmistakable. There was only one observer (MV) and the results are presented in Table 1.

The sex ratio was unchanged between 30 April and 14 May but was vastly different on 4 July (Table 1). The population had become small and consisted almost entirely of females with dependent young. One explanation is that the animals present on 4 July were unable to leave because the young were too big to carry but not yet able to fly long distances. Differences in the sex ratio of different *Pteropus* populations are known (C. Tidemann, unpubl.), although the only published data for *P. scapulatus* on the overall ratio of adult male: female was approximately 1:1 (Ratcliffe 1931). Data from this study show a different ratio (1:2.3), and more information is needed to resolve this discrepancy. It may be that sex ratios change with colony size, location and season. The proportion of non-breeding females within the colony was 10.3% and 14.7% on 30 April and 14 May respectively (Table 1). This is broadly consistent with Ratcliffe (1931) who reported 14% (N = 63) of females as non-breeding.

Stratification was evident within the colony. Births seemed to occur less than 10 m from the river and 2–4 m from the ground: no pregnant female was seen beyond this area and most females with young were contained by it. Copulation was observed three times on May 14 but in areas well away from where births occurred. In each case only one female was present in the company of several (4–6) males.

New born *P. scapulatus* were first observed on 17 April by Parks and Wildlife Commission staff (C. Palmer, pers. comm.) and again on 29 April and 14 May 1995. Six dead *P. scapulatus* were found: two female adults, two foetuses and two neonates. One was measured on the day of collection, 14 May 1995 (Weight 50.8 g; Forearm 52.1 mm). Twelve newly born animals were found alive and sent to volunteers for rehabilitation and eventual release. Most, if not all, of these animals died within a few days of collection (D. Sherwell, unpubl.).



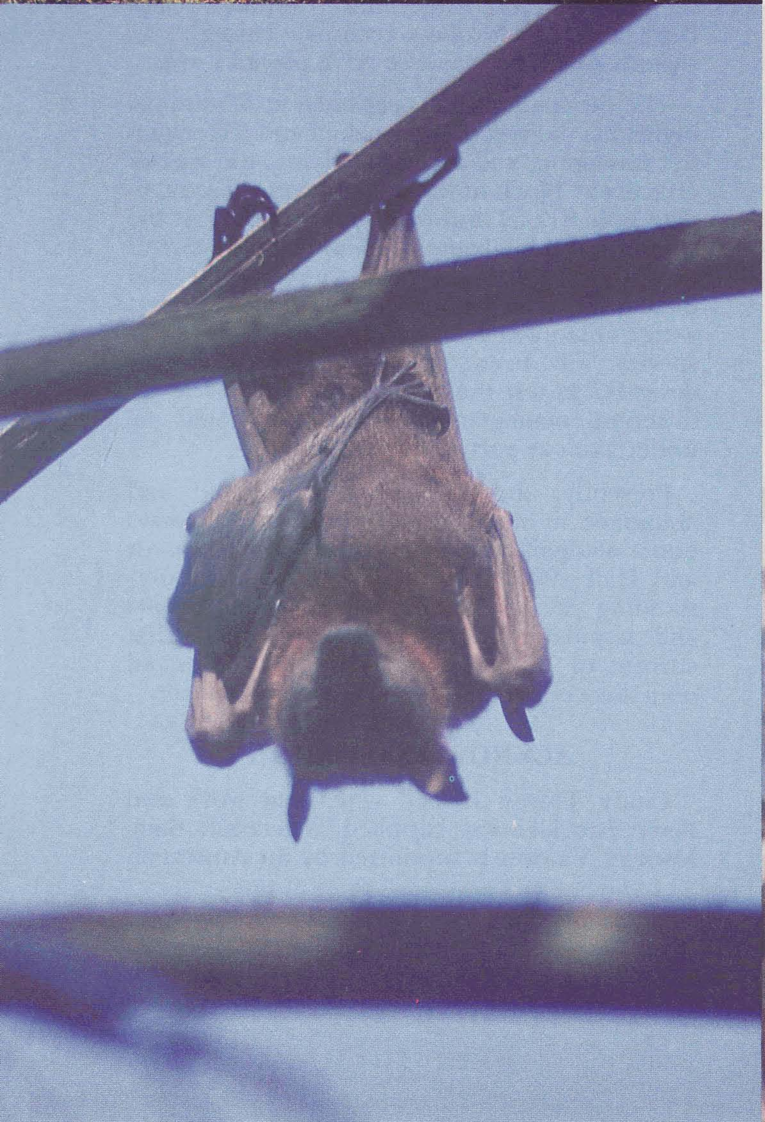


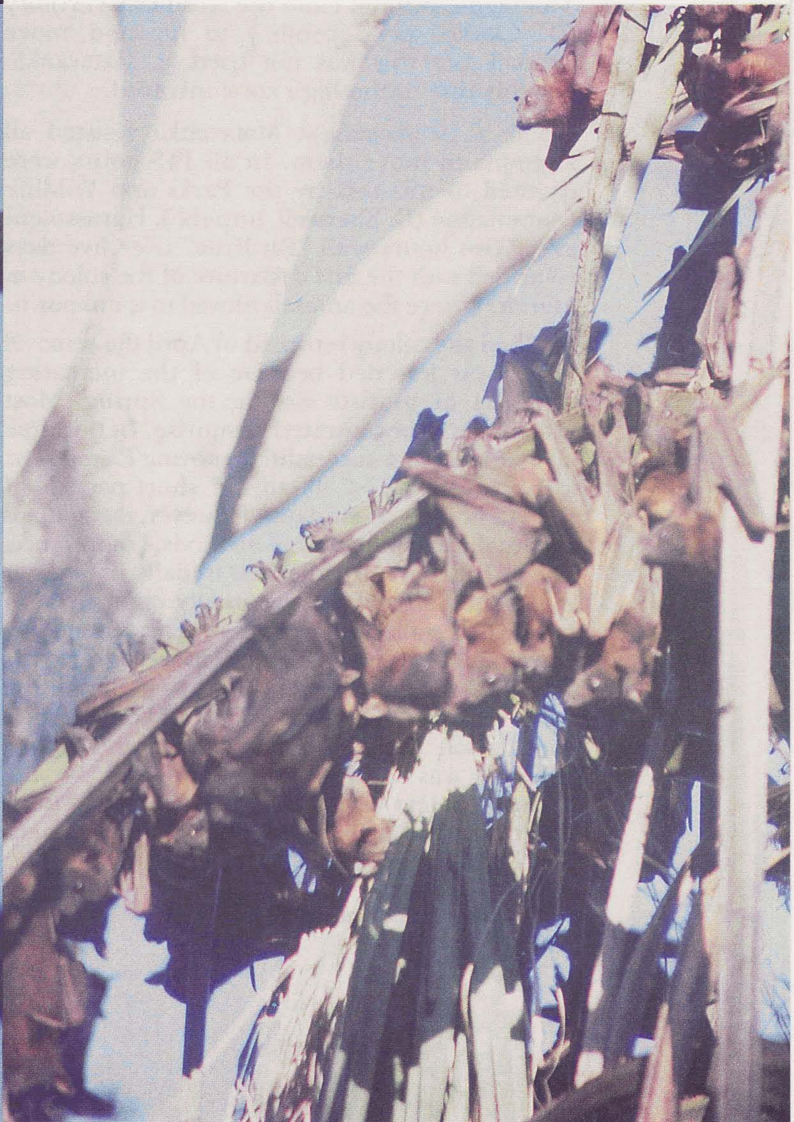
Top left. Flying-foxes hung like grapes in the trees with more than five hundred found on some paperbarks *Melaleuca argentea*. Photo: M. J. Vardon.

Top right. Many trees had leaves stripped and some had branches at least 25 cm in diameter broken by the combined weight of hundreds of roosting flying-foxes. Photo M. J. Vardon.

Bottom left: Neonates could be seen clearly suckling from their mothers. Photo: M. J. Vardon.

Bottom right: Palms *Livistona rigida*, were occupied by as many as a hundred flying-foxes. Photo M. J. Vardon.





Predation

Wedge-tailed Eagles *Aquila audax* and White-bellied Sea Eagles *Haliaeetus leucogaster* were observed to prey on *P. scapulatus*. Small raptors, mostly Black Kites *Milvus migrans*, were also present and harassed *P. scapulatus* females with young in an apparent attempt to force them to drop young. The young would have made easy prey. On one occasion the presence of a Wedge-tailed Eagle caused the overwhelming majority of the colony (80% or more) to take flight. Roosting Black Kites did not seem to disturb *P. scapulatus*, even when they were in the same tree.

Population removal

Several methods were used in an attempt to move the colony from the area around the Spring. These included: the use of "Birdfrite" and cattle crackers (both of which are fired from shotguns but only make a loud noise); harassment by light aircraft (up to 12 passes a day); water jets; and smoke. The use of lethal means of control was discounted (*P. scapulatus* may be shot under permit in the Northern Territory but few have been issued in recent times). Most activities were conducted shortly after dawn although aerial harassment continued throughout the day. A small fire inadvertently started beneath the colony kept the species away for a few days. Fire was not used subsequently because the first removed all the available fuel from beneath the colony. Helicopters have been used in Queensland (C. Tidemann, unpubl.) and the Northern Territory (D. Clarke, pers. comm.) to try and move animals but this was not tried at Mataranka, possibly due to the high costs involved.

The *P. scapulatus* at Mataranka resisted all attempts to move them. In all 143 hours were devoted to this task by the Parks and Wildlife Commission (D. Sherwell, unpubl.). Harassment every two hours with "Birdfrite" over five days coincided with the first departure of the colony in March. Where the animals moved to is unknown.

When the colony returned in April the removal effort was lessened because of the increasing numbers of tourists visiting the Spring. Most efforts were concentrated at sunrise. In this time all methods were successful in moving *P. scapulatus* a short distance (< 300 m) for short periods of time (2 hours – a few days). However, the animals eventually habituated to all methods. For instance, one "Birdfrite" cartridge was initially enough to move the animals but eventually eight fired in rapid succession were needed to achieve the same effect. The animals seemed to recognize the sound of the water pump used to generate the water jet sprayed at them and would depart their roost when the pump was started and return when it was switched off! *Pteropus* have the capacity to learn (Ratcliffe 1931) and this must be considered when developing management strategies for the genus.

CONCLUSION

The movement patterns of *P. scapulatus* are not understood (Sinclair *et al.* 1996) and the reasons for the occurence of large numbers of *P. scapulatus* at Mataranka in 1995, and the degree to which this event is unusual, are unknown. None of the long-term residents of Mataranka can recall having seen such large numbers of the species, and it seems safe to assume that their memory extends for at least 20 years (D. Sherwell, unpubl.). However, damaged vegetation in the surrounding area could be a result of occupation by large numbers of *P. scapulatus* at other times. Anecdotal information could not resolve this. Because the area is sparsely populated and still has much native vegetation intact it is possible that large numbers of the species do periodically visit the area but this has gone unnoticed or unreported.

Explaining this seemingly extraordinary event has proved difficult with available information. No change in the vegetation surrounding the colony has occurred recently. Climatic events may offer a possible explanation, and is proposed by Richards (1995) for movement of the species in north Queensland. In the Northern Territory the 1994–95 Wet season (October-April) at Mataranka was typical but record levels of rainfall to the north may be partly responsible for the colony's unusual size and persistence. Wet season rainfall in Darwin was a record 2 254 mm compared to the average for this period from the 1941–93 of 1 604 mm (Commonwealth Bureau of Meteorology records). Droughts in eastern Australia may also have played a role.

The occupation of *P. scapulatus* at Mataranka highlights the lack of information and techniques for managing, and indeed studying, the species effectively. Much of the information collected to date is anecdotal and our understanding of the species has not advanced greatly beyond that of Ratcliffe (1931). To properly conserve and manage *P. scapulatus*, especially when it conflicts with human activity, our understanding of the species will need to advance. Experiments designed to test the response of the species to different management strategies should be undertaken as part of this.

Presently, the species is widespread and abundant in northern Australia and appears under no significant conservation threat (Richards and Hall 1996). However, without an understanding of the species' habitat requirements and population dynamics, it is possible that current or future threats may go undetected until there is severe disruption to the population.

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